Jackson and Pargetter's Criterion of Distant Simultaneity

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Source: *Philosophy of Science*, Jun., 1979, Vol. 46, No. 2 (Jun., 1979), pp. 302-305

Published by: The University of Chicago Press on behalf of the Philosophy of Science Association

Stable URL: https://www.jstor.org/stable/187051

DISCUSSION

JACKSON AND PARGETTER'S CRITERION OF DISTANT SIMULTANEITY*

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Frank Jackson and Robert Pargetter (1977) propose a method for synchronizing clocks at rest at distant points of an inertial system in Euclidean space, which, they claim, (i) does not depend on Einstein's signalling method (Einstein 1923, pp. 27–29) and (ii) provides a basis for denying the conventionality of distant simultaneity. I am afraid, however, that the new method presupposes that the simultaneity of distant events relatively to the chosen inertial system has been already determined by Einstein's or some other method. Jackson and Pargetter describe their method as follows:

> Let U_A, U_B be clocks at A, B, respectively. Let XY be an axis perpendicular to AB, passing through C, the midpoint of AB. Take a rigid straight rod $A'B'$ with midpoint C' and length equal to the length AB. Move $A'B'$ with uniform velocity such that C' travels along XY towards C, and $A'B'$ is perpendicular to XY (i.e. parallel to AB); then if the reading . . . on U_A just when A' coincides with A is the same as the reading . . . on U_B just when B' coincides with B, clocks U_A and U_B will be synchronous. (Jackson and Pargetter 1977, p. 468).

I contend that the requirement that $A'B'$ remain at all times parallel to AB has no meaning unless the simultaneity of distant events is already defined in the rest-frame of AB. As $A'B'$ travels towards AB, B' will sooner or later cross all the parallels to AB that are crossed by A'. But we shall not say that $A'B'$ remains parallel to AB unless B' crosses each such parallel line *at the very time* that A' is crossing it. This condition makes sense only if there is a criterion for determining the simultaneity of distant events, viz. the event of A''s crossing a given parallel to AB and the event of B''s crossing the same parallel. Only if the required criterion is applicable to the

*Received October 1977; Revised April 1978.

Philosophy of Science, 46 (1979) pp. 302–305.

rest-frame of AB can one say that AB is parallel to each successive instantaneous position of $A'B'$ in that frame. Consequently, only if one already knows how to synchronize the distant clocks U_A and U_B at rest on AB can one test their synchronism by Jackson and Pargetter's method.

Jackson and Pargetter describe a procedure for ascertaining whether $A'B'$ tilts relatively to AB as it moves towards it. They imagine an electrostatic field in the rest-frame of AB, with a constant non-zero gradient perpendicular to AB. They expect that, if $A'B'$ is a conductor, a galvanometer placed at its midpoint will be deflected unless $A'B'$ stays all the time exactly at right angles to the field gradient, *i.e.* unless $A'B'$ remains parallel to AB. They apparently overlook that this relationship between the behavior of the galvanometer and the shape of each instantaneous configuration $ABB'A'$ is predicted by the laws of electrodynamics in their standard form, in which they are referred to an inertial frame for which the simultaneity of distant events is defined by Einstein's method (or, in other words, to an inertial frame relatively to which electromagnetic signals propagate with one-way velocity *c in vacuo*). Evidently, if the time coordinate is defined in the rest-frame of AB by some other method which does not yield the same partition of events into simultaneity classes as Einstein's, the laws of electrodynamics will take an unusual form when referred to that frame and will predict a deflection of our galvanometer if (though not only if) $A'B'$ remains parallel to AB throughout its motion. On the other hand, as we saw above, if the time coordinate in the rest frame of AB is not defined at all and distant events are not partitioned into simultaneity classes with respect to that frame, we cannot even *describe* the instantaneous position of a rod moving through it, let alone *infer* that position from the behavior of a galvanometer.

The present note's referee has devised still another method for ensuring that $A'B'$ does not tilt as it moves towards AB, so that the distance from A' to A is at all times equal to the distance from B' to B. This consists in affixing at C' a straight rigid rod $X'Y'$ perpendicular to $A'B'$ and taking care that $X'Y'$ slides along XY while $A'B'$ advances towards AB. It is clear that the mere coincidence of $X'Y'$ with XY throughout the experiment does not involve a criterion for distant simultaneity. However, such coincidence does not by itself imply that, throughout the experiment, the following holds:

(1) At each time t, the distance from A' to A at t equals the distance from B' to B at t.

To establish this conclusion we need some additional premises,

namely, (i) that throughout the experiment the rod $X'Y'$ remains perpendicular to the rod $A'B'$, while meeting it at its midpoint C'; (ii) that $A'C'B'$ is straight at all times; and (iii) that the relevant theorems of Euclidean geometry are, at each time, applicable to the configuration $ABCXYA'B'C'X'Y'$. In the light of our discussion in the first paragraph, it should be clear that (1) may hold or not depending on what distant events are taken to be simultaneous. Since the conclusion we are driving at thus presupposes a criterion for distant simultaneity but such a criterion is not involved by our main premise, it must evidently be implied by one or more of the additional premises, if the conclusion is to follow from them. As a matter of fact, it can be said to be implied by all three of them, as the following remarks should make clear. In the first place, the concept of a rigid body—illustrated by the T-shaped or cross-shaped system $A'B'X'C'Y'$—is not a geometrical but a kinematical concept, which lacks all meaning apart from time assignments to distant events. For a body is said to be rigid if all its parts stay at a constant distance from one another, no matter how they move relatively to outside things. But in order to make sense of the statement that the distance between two moving particles p and q is constant and hence the same at any two different times t_1 and t_2, p and q must have definite locations at t_1 and at t_2. This involves distant simultaneity, unless the constant distance between p and q happens to be zero. But this cannot apply to all particles of a finite rigid body. In the second place, though Euclidean geometry (in three dimensions) is in itself a timeless theory, its physical applications are not. Thus, for example, the geometry of the moving configuration $ABCXYA'B'C'X'Y'$ mentioned in premise (iii) depends essentially at each time on how its successive stages are carved out of Nature's flux. Even if we grant, for the sake of the argument, that spacetime has a natural and not merely a conventional affine structure (compare, for example, the discussion in Salmon 1977, pp. 281–302) and that on a neighborhood of our experiment it is practically flat, Euclidean geometry will not be applicable to a particular stage of the said configuration, at, say, time t_0, unless the time coordinate has been so chosen that, at t_0, all ten points $A, B, C, X, Y, A', B', C', X'$ and Y' lie on the same flat three-dimensional submanifold of spacetime. Jackson and Pargetter's assumption that space is Euclidean (Jackson and Pargetter 1977, p. 469), mentioned at the beginning of this note, can only mean that Euclidean geometry applies at all times to the set of unprimed points (the "stationary" system), for they cannot without begging the question prescribe the instantaneous geometry of any stage of the full—primed *and* unprimed—configuration.

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